ROLL NO. _____

Code: DE65 **Subject: CONTROL ENGINEERING**

DipIETE – ET

Time: 3 Hours **DECEMBER 2014** **Max. Marks: 100**

PLEASE WRITE YOUR ROLL NO. AT THE SPACE PROVIDED ON EACH PAGE IMMEDIATELY AFTER RECEIVING THE QUESTION PAPER.

NOTE: There are 9 Questions in all.

- **Question 1 is compulsory and carries 20 marks. Answer to Q.1 must be written in the space provided for it in the answer book supplied and nowhere else.**
- **The answer sheet for the Q.1 will be collected by the invigilator after 45 minutes of the commencement of the examination.**
- **Out of the remaining EIGHT Questions answer any FIVE Questions. Each question carries 16 marks.**
- **Any required data not explicitly given, may be suitably assumed and stated.**

Q.1 Choose the correct or the best alternative in the following: **(2×10)**

a. Stability of closed loop with positive feedback is

(A) More than open loop **(B)** Less than open loop
(C) Same as open loop **(D)** None of these

b. The laplace transform of unit step function is

(A) zero **(B)** one
(C) 1/s **(D)** s

c. If the system has not repeated poles on the j-axis, the system is

(A) stable **(B)** unstable
(C) marginally stable **(D)** conditionally stable

d. A unity feedback system with open-loop transfer function $G(s) = 4\,[s(s + p)]$ is critically damped. The value of the parameter p is

(A) 4 **(B)** 3
(C) 2 **(D)** 1

e. Considering the unity feedback system of Fig.1, the settling time of the resulting second order system for 2% tolerance band will be _____.

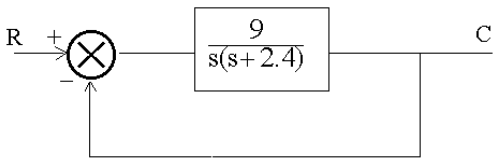

Fig.1

(A) 3.33 sec **(B)** 4.5 sec
(C) 2.25 sec **(D)** 2.84 sec

f. What is the critical point for G(s)H(s) in Nyquist stability critertion

(A) -1 + j 0 **(B)** 1 + j 0
(C) 0 + j1 **(D)** 0 - j 1

g. The electrical capacitance is analogous to

(A) Viscous damper **(B)** Spring
(C) Mass **(D)** None of these

h. The open loop transfer function has 4 poles and 1 zero. The number of branches of root locus is

(A) 4 **(B)** 1
(C) 5 **(D)** 3

i. Routh Hurwitz criterion gives the number of:

(A) roots in right half of s-plane
(B) roots in left half of s-plane
(C) roots in right half of s-plane and / or roots on imaginary axis
(D) roots in left half of s-plane and / or roots on imaginary axis

j. Given that the transfer function G(s) is $k/(s^2(1+s))$, state the type and order of the system:

(A) 2 and 3 **(B)** 3 and 2
(C) 3 and 3 **(D)** 1 and 3

Answer any FIVE Questions out of EIGHT Questions.
Each question carries 16 marks.

Q.2 a. Compare open loop & closed loop control systems using suitable example. **(6)**

b. Describe a two phase a.c. servomotor and derive its transfer function. **(10)**

Q.3 a. The transfer functions for a single-loop non-unity-feedback control system are given as **(9)**

(i) $G(s)H(s) = \dfrac{4}{(s+1)(s+2)}$

(ii) $G(s)H(s) = \dfrac{2}{s(s+4)(s+6)}$

(iii) $G(s)H(s) = \dfrac{5}{s^2(s+3)(s+10)}$

Find the steady-state errors due to a unit-step input, a unit-ramp input and a parabolic input.

b. Consider the closed-loop system given by

$$\frac{C(s)}{R(s)} = \frac{wn^2}{s^2 + 2\varsigma wns + wn^2}$$

Determine the values of ζ and wn so that the system responds to a unit step input with approximately 5% overshoot and with a settling time of 2 seconds (use the 2% error criterion) **(7)**

Q.4 a. Determine the transfer function of a control system shown in Fig.2: **(10)**

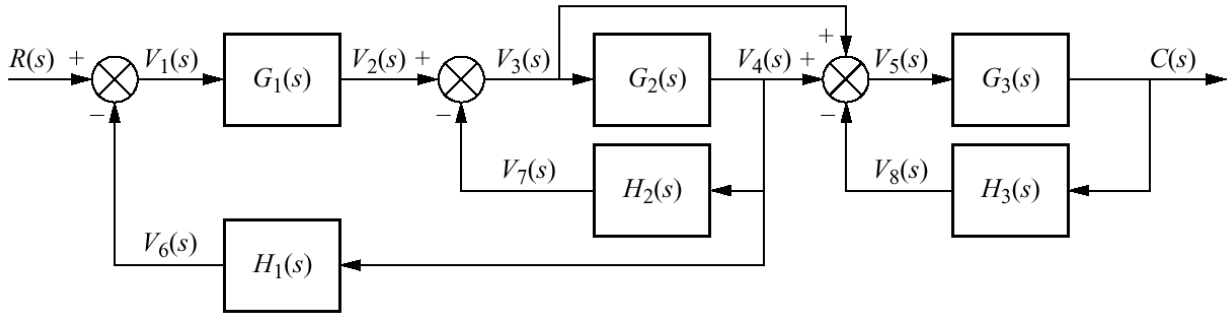

Fig.2

b. Comment on the role of positive feedback and negative feedback in closed – loop control configurations. **(6)**

Q.5 a. Obtain the transfer function C(s)/R(s) of the following signal flow graph as shown in fig.3 **(10)**

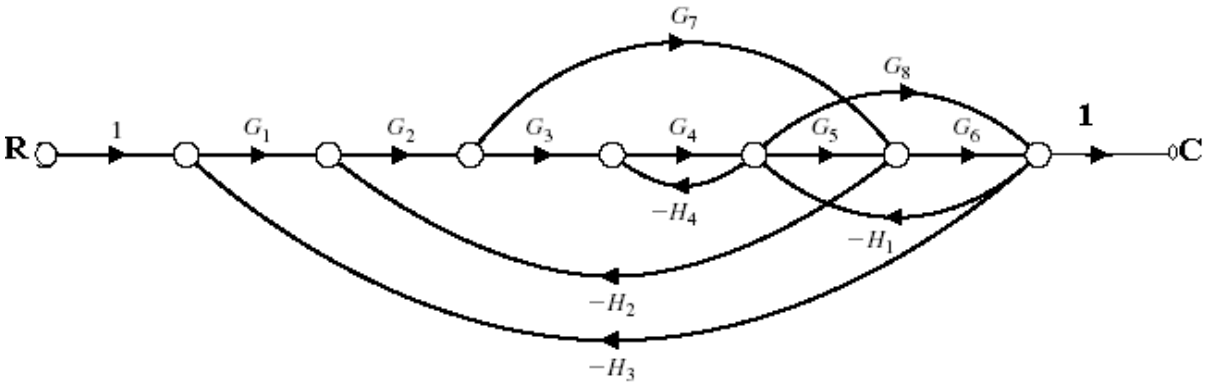

Fig.3

b. Explain a signal flow graph, a node and a branch with suitable diagrams. State and explain the rules of algebra of signal flow graph. **(6)**

Q.6 a. A unity negative feedback system has open loop transfer function of

$$G(s) = \frac{K}{s+4}$$

Consider a cascade compensator $G_C(s) = \frac{s+\alpha}{s}$

Select the value of K & α to achieve
(i) Peak over shoot of 20%
(ii) Setting time (2% basis) ≅ 1 sec **(10)**

b. Find sensitivity of overall transfer function w.r.t. forward path transfer function. **(6)**

Q.7 a. Draw the complete Nyquist plot for a unity feedback system having the open loop transfer function $G(s)H(s) = \frac{6}{s(1+0.5s)(6+s)}$. From this plot obtain all the information regarding absolute as well as relative stability. **(12)**

b. Discuss relative stability. **(4)**

Q.8 Draw the root locus plot for a unity feedback control system having open loop transfer function as $G(s) = \frac{k(s+3)}{s(s^2+2s+2)(s+4)(s+5)}$.

Thus find the value of K at a point where the complex poles provide a damping factor of 0.5. **(16)**

Q.9 a. Obtain Bode Plots for the system: **(8)**

$$G(s) = \frac{K}{s(s+1)(s+10)}$$

Also obtain GM and PM. Comment on stability.

b. Discuss M and N circles. **(8)**